STATE OF NEW HAMPSHIRE

Department of Environmental Services Communication

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From	Wayne Ives Instream Flow Specialist Watershed Management Bureau	At (Office)	Water Division
Subject	**Response to comments for the Souhegan Proposed Protected Instream Flow Report**		
To	Souhegan Technical Review Committee		
Attachments	Appendix 3 (revised 12/1/06) Appendix 17 (revised 12/1/06)		

This memo contains DES's responses to the Souhegan Technical Review Committee's comments concerning the May 22, 2006 draft Souhegan Protected Instream Flow Report. This report was presented to the Souhegan Technical Review Committee at the June 6, 2006 meeting where comments were solicited. Committee member comments are followed by DES's response to that comment in bold red text.

Extensive checks and revisions have been made to the report and to the Executive Summary in response to these comments. The Executive Summary provides a concise description of the results of the protected flow assessments and is designed to stand alone.

Please review these comments and responses. It is very important that the Technical Review Committee be in agreement that this version of the Souhegan River Protected Instream Flow Report (December 1, 2006) is approved for presentation to the public. Upon TRC approval, the public hearing will be held at least 30 days after the report is made available to the public and appropriate notifications are made.

Comments and Responses – Souhegan PISF report

Range of flows described in the PISF

The Executive Summary of the PISF states that the study "subscribes" to the natural flow paradigm, i.e. that natural extremes, such as floods, are important features of riverine ecosystems. EPA agrees and believes that the report should describe/ include these flows in the PISF for the river. At the TRC meeting on June 6 there appeared to be some confusion with respect to describing the full range of flows within the natural flow paradigm and the water management plan. EPA believes that the PISF should describe the full range of flows necessary to, among other things, "conserve, protect, maintain or restore aquatic life or habitat or both" (Env-Ws 1905.03). These flows should be described in the PISF independent of the system's ability to store and release flows, i.e. manage flows.

For example, various Index of Hydrologic Alteration parameters developed by The Nature Conservancy could be used to better describe the higher end of the flow spectrum. Connecticut DEP is considering using the following parameters to better describe "natural flows" at the lower end of the flood spectrum: high flow duration (2+ year event), high flow frequency (2+ year event), high flow magnitude (3-day) and high flow timing (1-day max).

Currently the Executive Summary (and the body of the report) breaks recommended flows into several categories and separates higher flows from the lower end of the flow spectrum. We believe that a method should be developed to describe the full spectrum of recommended flows of the PISF in a more concise way. The document should indicate the importance of protecting these flows and not just on whether or not active management could restore or maintain the flows. Information on the duration and frequency of these flows in addition to the magnitude is important to include in the PISF.

> **Response: Appendix 3 was rewritten to address the need for documentation of higher flows. The report text notes (page 107) the addition in Appendix 3 of historical average duration and timing 2-year and 10-year from the Indicators of Hydrologic Alteration tool. Protection of higher flows will use management to limit the reduction in frequency and duration of these flows from the values described.**

Fish and Aquatic Life Instream Flows

Table ES3 provides instream flow for fish and other aquatic life for the upper and lower river. These numbers represent a large portion of the proposed PISF for Souhegan River.

We have reviewed both the text and appendices, which describe the assumptions and methods used to develop habitat suitability criteria for the rearing and growth and spawning periods described in the table and elsewhere. The assumptions and methods need further explanation and clarification. Subsequent to the June 6, 2006 TRC meeting we began more detailed discussions with the contractors on this topic and the discussions are ongoing. It is important that these issues be clarified both for the purposes of the PISF, but also for the eventual review and approval of the PISF as the water quality criteria for the Souhegan.

> **Response: A new Appendix (17) was created to further detail the methods and assumptions. This appendix showed the formulas and data sets used in the calculations of PISFs for one of the Souhegan representative reaches.**

While development of an estuarine flow standard may not be directly analogous to a freshwater flow standard, nonetheless, the following general advice for developing a criterion or index such as the PISF is relevant.

Effective protection and management of the estuary requires an index[1] of the estuary's response to freshwater inflow that 1) can be measured accurately easily and inexpensively; 2) has ecological significance; and 3) has meaning for non-specialists.

> **Response: Stream flow can be measured easily and accurately using the existing stream gage without additional funding. The protected instream flows are defined using stream flow magnitudes keyed to two index locations where stream flow data are needed. If another gage is not established at the second index location, sufficient correlation has been made between the index location and the existing gage to support management.**
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> **The protected flows magnitudes and durations are biologically significant since they were established on biological factors although some components are related to human flow needs. The timing of flow needs was determined from biological life-cycle needs. Frequency of flow events are described for aquatic or riparian plant and animal species.**
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> **The result of implementation of the protected flows will be protection of the human and riverine protected entities identified by the state legislature as important features of any Designated River and identified specifically on this Designated River.**

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[1] Managing Freshwater Discharge to the San Francisco Bay/ Sacramento – San Joaquin Delta Estuary: The Scientific Basis for An Estuarine Standard, 1993, Conclusion and Recommendations of Members of the Scientific, Policy, and management Communities of the Bay/ Delta Estuary

Throughout the process, I have been impressed by the high quality science work applied to the Souhegan River. Multiple IPUOCRs were assessed in detail with the benefit of high quality field inventories, GIS mapping, and new modeling approaches. The consultant team should be applauded for their hard work and synthesis. The information must be presented in language and format that is accessible and useful to managers and decision makers to not only inform and protect instream flows, but also to demonstrate that the process is successful.

Comments:

1. It was important that this study provided information using the Natural Flow Paradigm, the concept of natural ranges of variability, and a strong emphasis on biological and ecological theory (e.g. bio-periods). This context provides information across the range of flows inherent in any dynamic river system. I hope that this context continues to be a strong focus of future Instream Flow studies.

    Response: Agreed. The Natural Flow Paradigm (described by Poff et al., 1997) is fundamental to the effective development and description of protected flows. Only by recognizing that the range of natural flows are best suited to maintaining the biological integrity of the native river species can a framework be developed for water management decisions. The range of variability of streams both supports the native species, and also makes prediction of a daily stream flow impossible. These contrasting conditional requirements of variability and predictability require a method that can accept the entire range of natural flows as the acceptable condition. That protection is tied to maintaining the timing, frequency, duration, and rate of change of the magnitude of flow. These additional components of the Natural Flow Paradigm allow the identification of the extent to which a flow regime is flexible enough to provide for off-stream uses.

2. While maintaining low flow to support IPUOCRs is the focus of the contracted report, the team's focus on Natural Flow Paradigm warrants recommendations across the natural range of variability for common flows, as well as high and low flow extremes. With only a low flow recommendation, the study may inadvertently suggest only protecting the lowest target flow without protecting all flow levels identified (i.e. common, critical, rare). It is my hope that all flows receive due consideration and protection as guided by the Natural Flow Paradigm. In addition, more attention to the issue of infrequent higher flows warrants consideration, particularly because some of the non-human IPUOCRs require high flows in order to ensure they are sustained over the long term (e.g. floodplain forests and associated species).

    Response: While the low flow protections receive much attention, included in the report are recommendations for high flow events to support the less-frequent high flow needs of the river. In addition, Appendix 3 now includes values for small and large floods (2-year and 10-year events) from the Indicators of Hydrologic Alteration tool. In practice, it will be difficult to manage high flow events, but the report includes documentation of the levels and frequency of these

needs as well as the time of year they are most useful if that is a factor of the flow need. An example is the Silver Maple floodplain forest in the lower Souhegan where flows of >11.7 cfsm are required once every 1 to 3 years. While we cannot create these flows artificially, we can protect them by first identifying them and then developing water management plans that maintain their Natural Flow Paradigm characteristics.

3. Currently the report is formatted and written as a summary of research undertaken, rather than a logical justification for a set of flows to be protected in the management study. While this comment reflects a primarily stylistic preference, I think the current format is difficult to read and to follow. Additional thought should be given to how to present a well justified argument that can efficiently guide the work and recommendations of the WMPAAC. This is most crucial for the Executive Summary (see below).

   Response: While a major revision of the report structure is impractical, this consideration has been incorporated into the Executive Summary.

4. Given that this is a pilot study and is meant to inform how additional instream flows are determined across multiple rivers in New Hampshire, I hope that the consultants can provide information on what is critical to include in future studies, and what may not be require to include in future instream flow studies. The consultants are in the best position to evaluate their own methods, the usefulness and efficiency of the instream flow study; teams evaluating this project, including DES staff, will be better informed on how to guide future work with this kind of documentation.

   Response: This is an overarching goal of the pilot program, which includes both the Souhegan and the Lamprey Pilots. A final review of the program is scheduled for a year after completion of these pilot studies. The answers to what is most critical are best left to the completion of the Pilot Program when an evaluation of the lessons learned will be most timely.

5. While it is important to mention that other habitat restoration activities in addition to flow (e.g. temperature, woody debris, water quality, etc.) would improve the hydrologic processes in the Souhegan, the focus of this project should focus on flows. It is important to maintain a flow focus because we can not assume that managers will have the ability, expertise, or scientific background to act on non-flow strategies, particularly given that the consultant team did not focus on these additional restoration issues.

   Response: Non-flow related strategies for protecting instream habitat must remain of secondary importance under this program. This study report is focused on identifying protected instream flow needs. The Water Management Plan will then describe flow management alternatives. The recognition that, while flow is a master variable in habitat suitability, other factors can have large impacts is important and needs to be stated, but it is not part of the scope of this project.

6. More information and guidance is needed to inform managers and decision-makers about how to react to rare and critical flows, and what suite of management strategies are available to water managers when responding to such conditions.

   Response: Management alternatives will always be a case-specific issue. The pilot program includes interviews with water users and dam owners to determine their preferences for various management alternatives. Each Affected Dam Owners and Affected Water Users water management plan will be tailored to their circumstances. Their plans will have specific activities tied to flow conditions. The preliminary alternatives that are presented in the Water Management Plan will be examples of the most likely alternatives: those that are selected will be the most effective and least obtrusive. The initial listing of alternatives and the selection process should provide a library of management alternatives that will help in developing future Water Management Plans.

7. **Executive Summary**. I believe that the Executive Summary is a critical part of the document. Due to the detailed and technical nature of the project, the Executive Summary should provide understandable and useful summary information and recommendations for a broad audience that may not read or understand the full report. The audience will be broad, including the lay public, scientists and technical consultants, and decision-makers. It will be the one "chapter" of the document most people read, and thus requires a high level of clarity, written in language that a broad audience can understand, while preserving the scientific rigor embedded in the main body of the document. Conclusions should be clearly stated and easy to find. It should be written with the assumption that it can stand alone, with the most important figures and tables with captions, and reference to the main document and appendices. With these basic principles in mind I offer the following specific comments:
   a. Basic historical background and methodology paragraphs should be shortened and/or stricken in favor of a focus on results. Audiences can refer to the main document for details on these topics.
   b. Recommended instream flows should be clearly stated under a results section at the very beginning of the Executive Summary with justification following in clear, easy to read, bulleted format. Where flow recommendations are complex and focused on how they trigger management actions (e.g. rare flow durations), these concepts need to be clearly stated and highlighted, given their technical and potentially confusing detail.
   c. Technical details and terminology such as controlling flows; human- and non-human related instream flows; highest low flow PISFs; common, critical, and rare flows; synthesized flows; etc., are all important, but are currently very difficult to understand and follow, even for a scientific audience. Using a diagram or flow chart to depict how these concepts are related, or using very brief bulleted text to describe how these are all linked, would be very helpful. A glossary may also help in this regard, (e.g. with technical terms bolded throughout the text).

d. Be judicious about which figures to include. For those in the Executive Summary, please include a caption with sufficient explanation, with the assumption that the reader may not refer to the text.
e. All acronyms need to be spelled out the first time they are mentioned (e.g. AWU, ADO, GRAF, etc.).
   Response: The Executive Summary has been extensively revised into a document that stands alone to describe the results of the Souhegan PISF study. Every effort is being made to make it clear and understandable. A separate list of acronyms has been added to the text.

Thank you for the opportunity to provide comments to you and the consultants. The science and synthesis in the report and Executive Summary represent a huge advance in this discipline and I am certain that, with revisions, the documents will provide an excellent foundation for establishing useful flow recommendations for this and other rivers in New Hampshire. Please do not hesitate to contact me for more information.

1) Is it appropriate to compare data from sites from which the data were collected using different methods (e.g., backpack electrofishing was used to collect the fish data for the TFC, whereas only grid electrofishing was used for the Upper Souhegan and only snorkeling was used for the collection of the Lower Souhegan existing fish community data)?

    Response: Yes, in this context it is appropriate to compare backpack electrofishing data (Target Fish Community) to grid electrofishing data (existing fish community) given that we are concerned only with the proportions of species within the communities of the reference rivers (Target Fish Community) and the study river (existing fish community).

    It is probably less reasonable to compare backpack shocking to snorkeling (Lower Souhegan River), however due to water depths and the inaccessibility of our study sites to an electrofishing boat, snorkeling was the best available survey method. If boat shocking had been possible and were used as a sample method for the Lower Souhegan River, the problem of a comparison between two different methods would still have existed.

    Setting gill nets to capture fish is another deep water sampling method for sites that are too deep to backpack shock and not accessible by boats. This method would also have resulted in an issue with the comparison of backpack shocking to gill net samples, one which we believe would have been worse than the comparison between snorkeling and the backpack method.

    Given that snorkeling was the only feasible sampling method, and that we are only comparing proportions of species, we believe that the comparison of these data is acceptable. We are not making any comparisons between densities or population estimates of fishes. Such comparisons would not be valid using different methods. By sampling multiple habitat types throughout the river we are able to get an accurate estimate of the proportional make-up of the community. Similarly, we use multiple data sets for each reference river to achieve the same result when developing our Target Fish Community. As Target Fish Community methodology becomes more widely recognized, adopted, and applied a greater database of grid electrofishing data and potentially snorkeling data will become available for use in developing Target Fish Community models.

2) Page 249-250: For the determination of whether a species was over- or underrepresented, there is no measure of variability within the data used to generate the TFC. Therefore, please document the rationale for using the values in the following statement, which is on page 250: "Species existing in proportions more than 50% lower than expected were considered underrepresented and species existing in proportions more than 50% higher than expected were considered overly abundant." Of particular note is that on page 47 of the May 24, 2006 draft of the Souhegan River Protected

Instream Flow Report, it is stated, "Species with proportions 50% lower than expected were considered underrepresented and species with proportions 30% higher than expected were considered overabundant." Which is correct, and what led the authors to conclude that 50% is an appropriate value for this analysis?

Response: A 50% difference between the target proportion and existing proportion was chosen to determine under-represented and overly abundant species. This value was chosen arbitrarily: It was not based on any measure of variability within the Target Fish Community data as such a method had not been identified in any existing Target Fish Community literature. We considered 50% to be an apparent or obvious deviation from the Target Fish Community proportions. For lack of a documented alternative method, we used it as a benchmark to identify overly abundant and under-represented species.

Previous Target Fish Community analyses had not identified any method or criteria for making this decision. We realize that a better (statistical) method of making this determination should, and most likely will be developed for future Target Fish Community projects. Also, differences or similarities between Target Fish Communities and existing fish communities, as measured by the percent model affinity procedure (Novak and Bode 1992), should be statistically analyzed to develop a method of determining the degree to which the study stream is impacted (slightly impacted, moderately impacted, severely impacted, etc.). These caveats of Target Fish Community models should be resolved, but it was not within the scope of this project to develop or enhance the methodology.

3) Methods described in Appendix 6: There are several concerns about the results generated from comparing data collected using different methods. The data used to generate the Lower Souhegan TFC were collected, it appears although not documented in the Appendix, using backpack electrofishing. The data used to generate the existing fish community for the Lower Souhegan River were collected using a different method, snorkeling, which entails visually identifying individual fish to the species level. There are several potential problems with comparing the TFC and existing fish community data. Backpack electrofishing (especially with blocking nets) can effectively capture fish, including relatively rare species and larger adults. It is used only in areas in which the water depth does not exceed about 3 feet. Snorkeling can also be an effective method to "capture" (i.e., visually document) fish. However, identifying fish to the species level, especially small individuals, can be very problematic, if not impossible, using this method, especially in relatively deep (i.e., > 3 feet) water. For example, it may be very difficult to determine the difference between common shiner and fallfish unless the observer has the individual fish in hand. Furthermore, large individual fish may escape visual detection simply because they often do not allow the observer to get within visual distance of them. For example, in Table 6, white sucker were considered under-represented. Small fish, and especially those species that tend to blend in with the substrate and/or remain immobile when they detect the observer, may be missed

entirely. Those species that spend much/most of the daylight hours underneath substrate (e.g., slimy sculpin, American eel and perhaps longnose dace) would also escape visual detection.

Response: We were confident in our ability to identify all observed fish to the species level with a high degree of certainty with the exception of differentiating between fallfish and common shiner. Discriminating between these two species was difficult given their morphological similarities. This issue was realized prior to conducting surveys so the results for these two species were evaluated. (See response to Question 10). The evaluation indicates that the observed ratio of fallfish to common shiner fits with observed proportions from samples collected in previous Souhegan studies.

We realize that some individual fish may have been missed (unobserved) during our snorkeling survey of the Lower Souhegan River. However, of the top five TFC species (white sucker, fallfish, common shiner, blacknose dace, and longnose dace) only white sucker was found in proportions less than expected. We do not feel that white suckers, or large fish in general, were underrepresented as a result of our survey method. Many common white suckers of large size were observed (including one exceptionally large individual) while conducting our snorkel survey. Large trout (*salmo trutta* and *onorynchus mykiss*), which are known to be very skittish or easily frightened and driven to cover, were also observed closely. It is more likely that there is an actual under-abundance of white suckers in the Souhegan River as a result of habitat fragmentation by dams. Using MesoHABSIM modeling we were able to document that the majority of suitable adult habitat for white sucker is found within the Lower Souhegan, while the majority of suitable spawning habitat for this species is in the Upper Souhegan. Two dams between the Upper and Lower Souhegan (at Milford and Wilton, NH) prevent adult white suckers within the Lower river from accessing spawning habitat within the Upper river, and potentially prevent the movement of juvenile white suckers from the Upper river to the Lower river.

Fish that utilize heavy cover (e.g., substrate, vegetation, undercut banks, etc.) may not have been detected by the observer during the snorkeling survey and we realize that such species may have been underrepresented as a result. Of these species, only longnose dace was among the top five species within the TFC. This species was observed during the snorkeling survey in a proportion (4%) almost identical to the expected proportion of the TFC (6%). Concerns over the ability of snorkel surveys to accurately sample fish community proportions are justified. However, given the variability of depths, and limited access for large boats, snorkeling was the only feasible survey method for the Lower Souhegan River.

4) Table 5 contains a spelling error for the species name of brown bullhead.

Response: Thank you. This has been corrected.

5) TFC development: There are three fish species (brook trout, slimy sculpin and longnose sucker) that are likely to be inappropriate to include in the TFC, at least at the proportions in the current TFC. It appears that my comments sent to UMASS on December 19, 2005 and January 11, 2006 may have not been addressed. Specifically, has UMASS contacted NHDES regarding the validity of the species identification of longnose suckers in the Middle and South Branches of the Piscataquog River? That information was used in the development of the Upper Souhegan TFC. Also, it is of paramount importance that the data used in the development of the TFC come from the best reference streams for which data are available. As I stated in my comments sent to UMASS on December 19, 2005 and January 11, 2006, it appears that slimy sculpin would likely be present in the Upper Souhegan in either very low numbers, if at all, even under completely unimpacted conditions. Brook trout would likely be present, if at all, in the Upper Souhegan, but only in very low numbers. Of particular note is that no brook trout or slimy sculpin were included in the data from the reference rivers closest to the Upper Souhegan (Middle and South Branches of the Piscataquog River). Furthermore, the only reference rivers that contained brook trout are those in the Connecticut River Watershed. It is known that brook trout in the Connecticut River Watershed tend to be present in rivers of larger watershed size than in the Merrimack River Watershed. Therefore, including the Chickley, Cold, and Westfield Rivers as reference rivers may be inappropriate. These were the only reference rivers that contained slimy sculpin. Of particular note is the "highly significant under-representation of pollution intolerant species in the existing fish community of the Upper Souhegan with proportions differing by 88%" (on page 260). Three of the intolerant species were slimy sculpin, brook trout and longnose sucker, all three of which may be inappropriate to include in the TFC (at least in the proportions that are in the current TFC).

Response: All three fish species are expected to have occupied a limited part of the upper Souhegan River. Their numbers were not a large part of the fish community. Their rank in the Target Fish Community developed for the Upper Souhegan shows this minor role in the community.

Great care has been taken throughout this project to select the highest quality (ecologically healthy) reference rivers and data sets available. A Geographic Information System (GIS) was used to create a tool (Reference River Selection Model) capable of selecting reference rivers that were most similar to the Souhegan River based on physical characteristics and zoogeographic location (Level III Ecoregion). The process also included multiple reviews and opportunities for comments on the draft TFC models. The final TFC models and the reference rivers used in their development were subjected to reviews in multiple committee meetings and subsequently approved by a technical review committee. It is our hope that the level of care and review involved in the selection of the reference rivers resulted in the development of a Target Fish Community that is

representative of the fish community expected to occur or with potential to occur within the Souhegan River. It is important to recognize that TFC development involves the use of the best quality, or most ecologically healthy rivers available as references. In most instances this means that the reference rivers are in better condition than the study river for which they are being used as references. As a result they can be expected to support some species that may be missing from the study river. However, aside from the condition of the reference rivers, they are otherwise highly similar to the study river with regard to both physical characteristics and zoogeographic location. From this it can be inferred that differences in fish species between the TFC (developed from the reference rivers) are the result of factors contributing to the ecological health or conditions of those rivers. If clear differences between fish assemblages of a reference river and a study river occur and are the result of distributional patterns that can be explained zoogeographically, then that reference river would not be appropriate to use. In this case zoogeographics does not explain the fact that brook trout, longnose sucker and slimy sculpin are present within some reference rivers but not found within the Upper Souhegan River. It has been suggested that the patchy distributions of coldwater fish species (including brook trout, longnose sucker, and slimy sculpin), within New England, may be attributed to localized extirpations resulting from anthropogenic impacts associated with landuse and habitat alteration (e.g. deforestation, dams) during colonial times (Schmidt, 1986). Unfortunately since historical fish presence data, preceding European colonization of New England, does not exist we do not know definitively in what proportions these particular cold water species existed in within the Souhegan River, or whether or not they existed at all. Given this, and given the likelihood of the scenario that—extirpations lead to the current, patchy distributions of cold water fish species in New England – we do not feel that it is inappropriate to include such species in the TFC. Not including coldwater species that may have once existed within the Souhegan River and currently exist within reference rivers would not allow for an accurate evaluation of the current conditions. Leaving species out of the TFC would be as deceiving as adding species to it. Since we have no historical data for the Souhegan River, we can only rely on those proportions provided by the TFC. Understanding the uncertainty involved, but having no better method of assessment available, we have included a caveat statement to this regard within the TFC appendices, both below Table 6 (Upper Souhegan River species proportions comparison table) and within the discussion section.

It is important to note that none of these species (brook trout, longnose sucker nor slimy sculpin) were used as indicator species for the Generic Resident Adult Fish (GRAF) to determine instream flow

thresholds for Souhegan River Protected Instream Flow Study. Brook trout and slimy sculpin were considered Special Interest Fish (SIFI) within the Upper Souhegan River, and brook trout were considered a SIFI for the Lower River.

Longnose sucker have been sampled by NHDES in multiple locations within all three branches of the Piscataquog River and from other nearby rivers of similar size in within the Merrimack watershed. (e.g. M.B. Piscataquog, New Boston, 1996; N.B. Piscataquog, Weare, 1996; S.B. Piscataquog, Goffstown, 1996; S.B. Piscataquog, Francestown, 1996; Piscataquog, Goffstown, 1996; North Branch R., Croydon, 1997; North Branch R., Milan, 1998; Suncook, Chichester, 1999; Little Suncook, Epsom, 2001). Longnose sucker were also sampled from Baboosic Brook in Merrimack, (2000) which is a tributary (fourth order) of the Souhegan. Due to the fact that multiple sites within the region during different years recorded the presence of Longnose sucker, the credibility of DES data was not questioned. While it is known that this species does occur within the Connecticut and Merrimack River drainages within New Hampshire (NHF&G, *Fishes of New Hampshire*, 1947) it has been suggested that its distribution is limited to the northern-most parts of those watersheds (Scarola, 1987). As a result, some skepticism has been raised as to the authenticity of some or all of these samples. The possibility that these samples may have been misidentifications does exist. However, the possibility that these samples may not have been misidentifications also exists. This is not entirely unlikely given that longnose sucker exist within reference rivers which are physically similar to and located within the same zoogeographic eco-region as the Souhegan. Of particular note is that these rivers are within the same elevation range as the Souhegan River and lower latitude. Longnose sucker was included on the list of species considered native to the Souhegan River based on recent collection data, distributional accounts, or their potential to have been historically present. In an effort to keep with the methodology of the TFC framework we included all native species found within the quality reference rivers and did not alter the proportions from the proportions that were calculated using Bain's methods. However, given the lack of historic evidence or collection records of this species within the Souhegan River we saw it fit to include a caveat statement stating that it is unknown whether or not the proportions of coldwater species, such as longnose sucker, within the TFC are appropriate for the Souhegan River.

Research was conducted in an effort to identify historical land-use differences between the regions of the Southern New Hampshire reference rivers, and the Massachusetts reference rivers that were West of the Connecticut River. Works Progress Administration (WPA) maps from the mid-1930s were reviewed for several towns

where reference rivers were located. In general, the towns within which the Westfield River branches, and Cold and Chickley Rivers are located were less developed, less industrialized, and contained more forested areas than those towns where the Southern New Hampshire reference rivers were located. This could explain differences in fish communities (missing cold water species) between these two otherwise geo-physically and zoo-geographically similar watersheds.

Further, Hartel et al. (2002) cites a record (specimen) of slimy sculpin (p. 12) in the lower Merrimack River from the collections of Agassiz and Garman at the Museum of Comparative Zoology at Harvard University from the mid-late 1800s. The presence of slimy sculpin in reference rivers which were selected based on their geo-physical and zoo-geographical similarity to the Souhegan and accepted by the technical review committee, and the known historical specimen from the Lower Merrimack region combined with the belief that post-European anthropogenic impacts may have caused the extirpation of this species, led to our decision to include slimy sculpin in the Upper TFC. We acknowledge that they may have only existed in small numbers historically and feel that their position in the TFC is neither unreasonable nor an un-realistic target given conditions that would support a natural thermal regime within the Souhegan River.

Brook trout is another cold-water species for which regional declines and local extirpations resulting from anthropogenic impacts have been documented in New England (TU, 2004). It is likely that the absence of brook trout from some of the reference rivers, and from the Upper Souhegan River may be explained by factors associated with such anthropogenic impacts. As a result, there absence from many of the reference rivers should not, in itself, imply that they are inappropriate to include in the Upper TFC or that they did not occur within the Upper Souhegan historically. As a result these species were included in the TFC in their calculated proportions.

The Target Fish Communities do not mandate that exact proportions of species be met, but rather provide a gage for measuring or evaluating current conditions base on a comparison of the existing fish community to the Target Fish Community. Without regard to specific proportions, we feel that these species are appropriate to include within the Upper Souhegan Target Fish Community based on their potential to occur there under un-impacted conditions.

6) Please use “Lower” and “Upper” throughout instead of “lower” or “upper”.

Response: Thank you. This will be revised.

7) On page 260, the differences between the existing fish community and TFC is stated several times as being "significant". Please define "significant". Because there has been no evaluation of the variability within the data used to generate the TFC, there appears to no method to evaluate the statistical significance of any absolute differences between the existing fish community and TFC.

   Response: The use of the term 'significant' has been replaced with terms imparting only the importance of the difference where statistical significance is not appropriate.

8) Page 263: It is stated that "A comparison between the two communities illustrated significant under-representation of cold water species…". This comparison was reported in Table 6, and is the difference between "0%" and "1%" for brook trout. It does not seem reasonable to state that an absolute difference of <1% is "significant" under-representation. Please explain the rationale for the statement quoted above.

   Response: Based on our 50% deviation criteria this absolute difference between 0 and 1% does represent a significant numerical difference. However, we agree that this definition applied to very small numbers is statistically insignificant. Further the expected brook trout population may actually exist within the Souhegan River but due to high summer water temperatures were restricted to specific (and most likely small) areas of cold water (e.g. springs, seeps, tributary confluences) during our sampling. Hence, these fish were most likely not accounted for and may not actually be under-represented within the Lower Souhegan River. It is also possible that, given the small proportion of brook trout in the Lower Souhegan TFC (1%), and the variability of fish assemblage compositions between even highly similar streams, that the Lower Souhegan River may not have ever supported any wild brook trout. This issue has been addressed in the discussion section of the Target Fish Community report where it has been acknowledged that, given the modest target proportion of brook trout and the uncertainty of the historical presence and composition of this species within the Lower Souhegan River, the absence of this species from the Lower Souhegan may not be meaningful.

9) Page 249: How deep was the water sampled by snorkeling?

   Response: The majority of the Lower Souhegan snorkeling sites usually ranged between 2 and 4 ft. deep but also included deeper areas between 4-and 12 ft.

10) Page 257: Were the observers always able to differentiate between common shiners and small fallfish?

    Response: No, this is not an easy task. Common shiner and fallfish were only counted when a confident differentiation could be made based on size, body shape, and scale shape/color. This problem of identifying similar species was realized and considered prior to

conducting surveys. As a result after documenting these results, the proportions of common shiner to fallfish were compared to electrofishing samples conducted during this study on the Lower Souhegan (Site 7, Milford) and to other electrofishing samples collected on the Souhegan River where fish were identified in hand with greater confidence (NHDES (2002) and NHF&G (1987)). Proportions of common shiner to fallfish were similar between both methods and all surveys. These comparisons resulted in high levels of confidence in identification between these two species. This lent confidence to and supported, if not validated, the survey results.

11) Page 257: I suggest not using the term “lower segment” and consistently use “Lower Souhegan”.

Response: Thank you. This has been revised where such changes were appropriate.

12) Page 268: please include a citation that shows that temperature conditions in the Souhegan River exceeded the thermal tolerances of these species (slimy sculpin, brook trout).

Response: Thank you. This point has been noted and citations have been included within the report. A citation for the thermal tolerances of coldwater species is given and the main body of the Souhegan PISF Report contains the temperature data from the Souhegan River.

References

Hartel, K.E., D. B. Halliwell, and A. E. Lauer. 2002. Inland Fishes of Massachusetts. Massachusetts Audubon Society, Lincoln, Massachusetts.

New Hampshire Department of Environmental Services. 2002. Souhegan River fish survey.

New Hampshire Fish and Game Department. 1987. Souhegan River fish sampling at two 1000 meter sites, Milford, New Hampshire, summer 1987.

Novak, M.A. and R.W. Bode. 1992. Percent model affinity: a new measure of Macroinvertebrate community composition. Journal of the North American Benthological Society 11(1):80-85

Schmidt, R. E. 1986. Zoogeography of the northern Appalachians. Pages 137-159 in C.H. Hocutt and E. O. Wiley, editors. The Zoogeography of North American Freshwater Fishes. John Wiley & Sons, New York, New York.

Example of publications describing comparative studies of fish data collection methods

Cunjak, R. A., R. G. Randall, et al. (1988). "Snorkeling versus electrofishing: A comparison of census techniques in Atlantic salmon rivers." Naturaliste Canadien **115**(1): 89-94.

To assess the reliability of underwater counts of fish abundance, comparisons were made with electrofishing surveys at six sites on three rivers in eastern Canada. In general, snorkeling counts underestimated density, especially for younger (and/or smaller) fish which frequent shallow stream margins where underwater enumeration was difficult. Site-specific characteristics also contributed to the underestimates. Results indicate that underwater census methods, although potentially useful in some riverine conditions, were unreliable in small to medium-sized, rock rivers for the enumeration of juvenile salmon.

Dewey, M. R. (1992). "Effectiveness of a drop net, a pop net, and electrofishing frame for collecting quantitative samples of juvenile fishes in vegetation." North American Journal of Fisheries Management **12**(4): 808-813.

I compared quantitative samples collected by a drop net, a pop net and an electrofishing frame from vegetated habitats of a backwater lake in the upper Mississippi River. All gears sampled an area of 5.6 m squared. Catches with all three gears were dominated by juvenile centrarchids, mainly bluegills Lepomis macrochirus. In vegetated, turbid water, catches were significantly less with the electrofishing frame than with the two nets because observing and netting stunned fish was difficult. Capture efficiencies with the electrofishing frame were much higher in nonvegetated, relatively clear water (mean efficiency, 80%) than in vegetated, turbid water (mean efficiency, 5%). Catches with the drop net and pop net were similar in both number and species composition. Both the pop net and drop net were well suited for collecting quantitative samples of small fish from vegetation.

Hayes, J. W. and D. B. Baird (1994). "Estimating relative abundance of juvenile brown trout in rivers by underwater census and electrofishing." New Zealand Journal of Marine and Freshwater Research **28**(3): 243-253.

Underwater census and single-pass electrofishing were compared for estimating relative abundance of juvenile brown trout in the Kakanui River, South Island, NZ. Mean sampling efficiency was lower, and the variability of sampling efficiency was much greater, for underwater census (0+ trout: hivin x = 0.38, s = 0.368; 1+ trout: hivin x = 0.62, s = 0.822) than for single-pass electrofishing (0+ trout: hivin x = 0.61, s = 0.143; 1+ trout: hivin x = 0.74, s = 0.171). Sampling efficiency of both methods was dependent on temperature. Electrofishing became less efficient at higher temperatures whereas underwater census became less efficient at colder temperatures. The low, and highly variable, sampling efficiency for underwater census of 0+ brown trout was related to substrate hiding behaviour which is dependent on temperature. A ratio method for comparing relative abundance estimates is presented. Minimum significance values for the ratio (R) were derived for 0+ trout using temperature adjusted sampling efficiencies. To be statistically significant, relative abundance estimates made by underwater census had to differ by a factor of 6-7 times, whereas those made by single-pass electrofishing had to differ only by about 2 times, depending on the number of fish counted. By confining comparisons of relative abundance estimates made by underwater census to the summer period, differences of about 3.5-4 times could be detected statistically. It was concluded that single-pass electrofishing is superior to underwater census for estimating the relative abundance of juvenile brown trout in shallow (lt 1 m) river habitat, especially when temperature varies widely as with season and time of day.

Heggenes, J., Brabrand, Age and S. J. Saltveit (1990). "Comparison of three methods for studies of stream habitat use by young brown trout and Atlantic salmon." Transactions of the American Fisheries Society **119**(1): 101-111.

Surface observation, diving, and electrofishing were compared as methods to study habitat use by young brown trout Salmo trutta and Atlantic salmon S. salar in a Norwegian river. These three methods often gave widely disparate information about habitat use by young of these two species. The probability of encountering individual fish varied when the same method was used in different habitats. Surface observation and diving produced similar results in habitats with low mean water velocities (<20 cm/s) and fine substrate (mean diameter, ó64 mm), whereas electrofishing was more effective than the sighting methods in shallow areas with greater water velocities and larger substrate.

Naismith, I. A. and B. Knights (1990). "Studies of sampling methods and of techniques for estimating populations of eels, Anguilla anguilla L." Aquaculture and Fisheries Management **21**(3): 357-368.

The performance of fyke netting was compared with that of electrofishing in an artificially stocked closed pond and in open waters with natural populations in the Thames catchment, England (UK). Seine netting, trapping and fyke nets of different mesh size were also compared using wild populations. Studies of mark-recapture and catch-depletion techniques for estimating population sizes and structures were included. It was concluded that no single technique was ideal because of the difficulties inherent in adequately sampling eels in all aquatic environments. Recommendations are made and the implications of fyke net efficiency for commercial fishing are discussed.

Thurow, R. F. and D. J. Schill (1996). “Comparison of day snorkeling, night snorkeling, and electrofishing to estimate bull trout abundance and size structure in a second-order Idaho stream.” North American Journal of Fisheries Management **16**(2): 314-323.

Biologists lack sufficient information to develop protocols for sampling the abundance and size structure of bull trout Salvelinus confluentus. We compared summer estimates of the abundance and size structure of bull trout in a second-order central Idaho stream, derived by day snorkeling, night snorkeling, and electrofishing. We also examined the influence of water temperature and habitat type on day and night counts of bull trout. Electrofishing yielded the largest estimates of abundance of age-1 and older bull trout. Day snorkeling counts accounted for a mean of 75% and night snorkeling counts a mean of 77% of the fish estimated by electrofishing. Numbers of age-1 and older bull trout observed during day counts did not differ from numbers observed at night. Water temperatures during underwater surveys were 9-13.5 degree C. Counts were not influenced by temperatures in this range; however, statistical power of the tests was low. The three sampling techniques yielded similar estimates of the size structure of the bull trout population. When compared with electrofishing, underwater estimates recorded fewer small fish and overestimated the size of some fish. We detected no significant interaction between the type of snorkeling count (day or night) and fish densities observed in different habitat types. Densities of bull trout observed during both day and night were similar, regardless of the habitat type. Under the conditions of water temperature, conductivity, visibility, and habitat in which we sampled, day snorkeling surveys were suitable for estimating the relative abundance and size structure of the bull trout population. Our results conflict with those of other studies that suggest night snorkeling is more effective than day snorkeling for censuring bull trout. Explanations for this discrepancy may include differences in stream temperature and stream channel features.

1. Important resources left out of the PISFs
The report seems to assume that the highest of the human flow needs (e.g. for recreation in the upper watershed) is too high to provide at all times and on that basis no PISF is recommended. The project team stated that storage in the watershed is inadequate to provide any significant maintenance flows for whitewater. In general this is true, and indeed, as the team points out, whitewater boating on the Souhegan is largely an opportunistic activity because of the flow variability. Paddlers take advantage of whitewater flows when they are available and go elsewhere or do other things when they are not.

On the other hand, this analysis seems to ignore another side of this same fundamental nature of many of the human instream flow needs. No boater, for example, would expect adequate flows at all times, but they do expect, over the long term, to have a certain number of opportunities to go boating (even if they don't actually make it out on the water). This opportunistic characteristic makes it very difficult to address in the current format for the PISF, but that doesn't mean it isn't important.

Even if we assume it is acceptable to the boating community to lose whitewater opportunities on the Souhegan (which, of couse, it isn't) the cumulative loss of that resource along with those on other rivers could eventually diminish boating opportunities dramatically on a state or regional level. We view the state's role as protecting the public interest in rivers against such cumulative impacts, since no one loss is sufficient to raise a significant public response. With that in mind, we believe the PISF should include some provisions to protect against such cumulative impacts.

We don't have a specific proposal for how to address this problem through the PISF, but one approach might involve evaluating the other protected flows against current use levels and estimating the amount of lost boating flows that might be expected to occur based on the historic hydrograph. With such an analysis, the PISF might then be able to include a threshold level of loss of boating flows beyond which additional management measures would have to be implemented. (These measures would probably have to be based on conservation and related measures, and may need to address users that aren't “affected water users,” for example, small well owners.)

Response: Recreational boating is a flow-dependent protected entity that requires protections. The flows most appropriate to the boaters surveyed have been identified and documented in the Protected Instream Flow report. Flows at the level of boaters’ interests are available as nature provides them and are not manageable in the sense that we can create them by management. Protection of these flows requires management of the water use by Affected Dam Owners and Affected Water Users so as not to reduce the frequency of these flows. The Water Management Plan will select the alternatives that protect the occurrence of these flows as it will for the flows needed for the entire population of flow-dependent protected entities. Management may not result in all flows for this protected entity being

retained just as all water uses may not have full access to this shared resource.

2. Confusing data in Table ES1

Table ES1 contains flow values for hydropower that don't seem to make sense. For the Upper Souhegan, 20 cfs is equated to 0.7 cfsm, yet 42.2 cfs on the lowest section (more than twice the flow, lower in the watershed) is equated to 0.44 cfsm (only about 2/3 of the flow higher up in the watershed). If these numbers are correct, they need to be explained as they don't make sense. If they are incorrect, they should be corrected.

Response: These numbers are correct. The two values in cfs and cfsm represent different ways of describing stream flow. The protected flow values have been determined at index locations for the Upper and Lower Souhegan. The protected flows are identified at these index locations in cfs (cubic feet per second). Cubic feet per second represent a rate of flow specific to these locations. Because stream flow increases with increasing watershed area, to apply the protected flows upstream or downstream of these index locations, the index location cfs value must be translated using a relationship between watershed area and stream flow.

This relationship is expressed in units of cubic feet per second per square mile of watershed area (cfsm). In a watershed of 100 square miles and a stream flow of 1.0 cfsm the stream flow is 10 cfs where the watershed is 10 square miles and 50 cfs where the watershed is 50 square miles. The cfsm value can translate the index locations' protected flow to any upstream or downstream location watershed area.

By converting index location cfs values to cfsm units the rate of flow is normalized to the average flow being contributed by a square mile of watershed. This is a useful unit for comparing flow at different places in a watershed. 20 cfs from the smaller watershed is a larger ratio (0.7) than 42.2 cfs from the larger watershed (0.44) just as a cup of water in a small saucepan fills more of the sauce pan than a gallon of water in a swimming pool. In Table ES1, while hydropower in the upper part of the Upper Souhegan uses less stream flow this represents a greater portion of the smaller watershed area's contribution. In the lower part of the Upper Souhegan, hydropower needs are for more flow, but this represents a smaller portion of the watershed contribution.

3. Many PISFs don't trigger management actions until duration criteria are met, yet there is no similar indication of duration criteria for flows that set the clock back to a zero duration. Many of the PISFs contain duration criteria as part of the protected flow. Flows that fall below a given level are allowed, but only if they don't last longer than a specified length of time. If flows rise above those trigger levels before the duration is met, the clock is reset even if flows drop below the trigger level again quickly. While this may be unlikely on many of our larger

rivers (due to hydrologic factors), this seems like it could be a factor on smaller and/or upstream segments of many of our RMPA rivers.

It would seem that in order to recover from low flows, rivers would need to exceed the trigger flows for a certain amount of time. We would like to see some discussion of this issue and whether or not it is relevant to the PISFs on the Souhegan. Admittedly, this concern is theoretical since we don't know of any evidence that it is relevant on the Souhegan or any other river, but it may well be a factor on other rivers, and the issue should be acknowledged and addressed as appropriate.

> **Response: The magnitudes and durations of flows have been determined. Also, frequencies of certain flow magnitudes have been defined. In most cases, these parameters are also tied to biologically significant time periods during the year. Management responses when these conditions are not meet must be developed during the Water Management Plan process. However, the identification of when a PISF is or is not met requires definition of if and whether flows that rise above a threshold should reset the count of the duration of days beneath that threshold. Text has been added specifying that two days is the duration of flows above threshold required to reset the duration count.**

Thus far these three issues are the only substantive comments we have for the draft PISF. Again, much of the work is sound and the effort has provided us with a large new body of information to help with water use management. I think the remaining issues for the PISF are few. Still, much of the work has been left for the WMPAAC and the water management plan, and the technical aspects of flow protection will still depend on what happens during that phase.

First I again emphasize, that the consultants have done an excellent job accumulating a wealth of relevant field and literature data on the IPUCOR values and processing it with limited resources and short time frames. The flow-dependent instream protected uses, outstanding characteristics and resources (IPUCOR) entities were publicly reviewed and accepted. The research on these appropriately varied from actual measurements to sightings of the resource, the latter supplemented by indirect approaches to determine the range of instream flow needs (e.g. literature, modeling, etc.). The methods used, though debatable as many methods are in science, are creditable, scientifically recognized and were openly reviewed prior to being applied and accepted.

The following comments are intended as constructive recommendations before the final version goes out for public review. They focus on how to make what is presented in the Executive Summary the tools they need to be.

This project essentially has two major purposes, first to develop a pilot approach for the state of New Hampshire and second to use the Soughegan as one of the test models. This requires the final product to be applicable to the Soughegan, but also provide a sense that the applied strategy will work on other rivers and how. What is absent in the report is a clear, concise, not overly technical chapter that says "knowing all we know, here is how to use the results in the regulatory world NH DES will have to apply it" in and the users will have to be able to understand as well without having to hire a consultant. This is not a dumbing down of the text, rather the need for a translation from the sophisticated support information in the main body of the report into to a workable and functional tool. As was suggested at the meeting this includes:

- Keep the executive summary less than 20 pages, the longer it becomes the less it will be used. It should be able to stand on its own as a whole document.
- Shorten the background information, methods, etc to less than 1 to 1 ½ pages and use references to specific chapters/sections for the reader needing a quick road map to more detailed information. Then use a page or so to explain the particulars of the Souhegan watershed and why it was divided into two sections when applying the results.
- Reduce to a minimum/eliminate scientific jargon, acronyms, etc and when the latter are used tell what they are (or create w/in this Executive Summary a quick to find glossary of them). The Executive Summary should be understandable to many, not a select few experts. Each sentence or paragraph should not require a lot of cross-referencing to find out what a term/acronym means. The public paid for the report and they should have a chance to understand the fundamental results if they read the summary.
- Following the abbreviated purpose and method sections, describe what the natural flow paradigm is and how it applies to the underlying science and results, again with brevity and simplicity in language.
- Then go the hard of the matter – explain what the most fundamental results are and how to use them so that the Water Management Team has an understandable scientific floor to build up its plan from. The 'in stream flow" science effort was intentionally designed to be first and to keep the science separate from the politics of the Water Management Plan. Specifically when should flows not be less than "x" cfsm or cfs, for what approximate duration, and frequency and by defined months or seasons. Similarly it should explain what high flows are needed to protect those IPUCOR values that need them, based on the natural

flow paradigm. Otherwise with increased water demand, future population growth, etc, a river could see skimming of high flows becoming a detriment. The last version of the Executive Summary makes progress on the low flow side, but excluding lip service to high flow needs, offers little quantitative guidance on what should be protected (even though the support data has been collected).

- The executive summary can briefly acknowledge tangential results on other anthropogenic caused factors than flow that may be limiting to certain IPUCORs (e.g. heat, habitat structure) to help other remedial programs, but in themselves should not be the driving factor for this report.

I appreciate the magnitude of the overall task and the well-done supporting science. The supporting data for a functional instream flow strategy is present for a very creditable approach. Hopefully my comments provide guidance to achieve the desired end-product, one that is useable in the arena intended and that possibly creates the prototype for other rivers in New Hampshire (and New England?). It is an ambitious but achievable goal.

Response: Agreed. The Executive Summary has been extensively revised and is less than 20 pages and for precisely the reasons stated. Additional information has been added to the Executive Summary; however it will focus mainly on results and contain process or background information only to the extent necessary. The Executive Summary has been made as clear as possible by reducing or eliminating acronyms. A glossary has been added for reference to all acronyms in the report. Other-than-flow factors that might support the Instream Flow Program goals will be acknowledged only briefly as a notification that there may be other alternatives.

The Study Team has proposed an approach that would select certain flows, generally high exceedence value flows, for "management," while the remainder, being the majority of the flows would not "warrant protection," E.S. p.7. This proposal is troubling for a number of reasons. From the start of this pilot instream flow study, a great deal of emphasis has been placed on the notion that the end result of this process would be to protect the natural flow regime on the Souhegan.

Unfortunately, the draft report does not appear to reach far in that direction. The flows that are cited for "management" (critical and rare) as discussed on page 123 of the main report also have duration periods attached that effectively push action thresholds into hydrologic conditions that have high or very high exceedence values. This focus on low flows and high exceedence value flows, and a duration period of several days during the various bioperiods means that commonly occurring flows and high flows (low exceedence value flows) would not be, and in fact are not, recognized for "management." A potential outcome of this lack of recognition or protection is that this gap in coverage might be viewed as an invitation for unfettered access to Souhegan water by potential users.

Response: Water use is and will continue to be available to all riparian owners under the Water Management Plans. Previously, the use of water w subject only to reasonable use requirements under the Riparian Doctrine. That use has in the past been relatively unrestricted because only the courts could define what would be considered reasonable.

This report's quantification of the protected flow requirements now identifies flow values for maintaining the public trust. These flow requirements have been developed on the framework of the Natural Flow Paradigm. The Natural Flow Paradigm recognizes that protection of ecological flows is more than maintaining a single flow. Instead the need for flow variability within appropriate ranges during the year is also critical. The wide range of flows that occur during a year allow for off-stream water use within that seasonal and interannual range of variability.

While there is flexibility in flow requirements, there are limits to this as a resource. High exceedence flows tend to be the most sensitive to diversion both because their range of variability is narrower and because the flows are much smaller such that a diversion maintained during low flows represents a larger percentage of the resource. Water users will be subject to water management plans that will provide for their water needs and for meeting the protected flows such that the public trust is maintained.

The final version of the Executive Summary does not limit protections to high exceedence value flows. Protected flows have been described for common, critical and rare flows. Rare and critical flows are high exceedence value flows—stream flow will frequently be above these levels. Common flows are in the near optimal range for the protected entity identified and represent flows near the middle of

the flow regime for that bioperiod. The common flows identified are currently being met and with documentation of these flows, future water withdrawals will be managed so as not to violate them. High flow requirements have also been identified so that the frequency and durations of these flows can be protected. The critical and rare flows are not always being met and require management under existing withdrawal conditions. Documentation of protections for high flows has also been better described in the report especially Appendix 3 which was rewritten to address this concern as referenced in the revised main body of the report (page 107). The historical average duration and timing of 2-year and 10-year have been identified in Appendix 3.

It should also be pointed out that focusing management on rare and critical flow periods has two reasons. Water use during these periods affects flow regimes that have the least variability in magnitude and therefore the least flexibility. Second, in the course of the study it was recognized that the Souhegan River possesses insufficient storage capacity to affect medium to high flows (encompassing the common flows and higher). Therefore if flow is managed through reservoir operations, the only flows that could reliably be managed are the lowest flows. In order to manage the medium and higher flows management will focus on maintaining the flow variability, frequency and duration.

For instance, I cannot find any limitation imposed or implied that would prevent anyone from taking as much water from the river as they wish even to the point of drying the river, as long as they do not violate any specified duration period. Drying the river or parts of it for one day or a few days and other flow perturbations can do as much or more ecological harm as reducing the flow to the critical or rare levels and attendant duration periods proposed by the Study Team.

Response: We believe the likelihood of this type of withdrawal is low and that flow protection for rate of change will be prevented under the water management plans, however, additional evaluation has been conducted in the instream flow study to identify limits on rapid drawdown of the river by withdrawals or dam operations.

There is a theoretical possibility that a withdrawal could be engineered to cause the river to dry up within the interval of a bioperiod's protected flow durations or within a single day. This indeed could have disastrous impacts on aquatic biology and other water users. To create this effect would require a very large withdrawal that would need to be implemented over relatively short intervals. This would be a very inefficient withdrawal scenario. There currently are no water users who operate in this manner. These withdrawals would also need to occur at the lowest range of flows to have the capacity to dry out the river or at somewhat higher

flows they could result in dropping flows below a flow threshold. As described, this is a hypothetical scenario: there are possibilities that could evade the PISF described in Table 21. To avoid such loopholes, either the PISF must be re-drafted to account for all foreseeable possibilities, at all locations along the river, or the water management plan is developed to address them. It is believed that the former will result in overprescriptive PISF that are so inflexible that they are soon obsolete. The latter, the water management plan, is therefore better suited to deal with the variety of hypothetical scenarios. The rate of change parameter for determining appropriate withdrawal patterns under a water management plan has been evaluated. The evaluation of recession rates has resulted in average and worst case recession values when flows are in the ranges defined as protected flows. The evaluation defined the flow recession rates at time scales ranging from 1 to 48 hours.

If this pilot process creates that result or perception, then it will have been an environmental misstep.

Response: We believe that these cannot occur with the additional information that has been developed and the operational conditions that will be incorporated under the Water Management Plans.

Accordingly, I believe a change in direction is warranted to get the focus of the Study Team back to the task of protecting instream flows for identified uses and the natural flow regime of this river. I believe this can be accomplished best by protecting the common flow levels identified for each use and bioperiod as these are based on results from the instream flow study.

Response: There may have been some confusion caused by the earlier version of the report, and that should be corrected now. We expect these revisions to meet the previous objections leading to this recommendation. Revisions to the report now make it clear that common flows are part of the protected flows: the report has identified the PISF, and these are the flows to be protected These revisions also document the mechanism using rate of change criteria to protect from withdrawals purposefully trying to circumvent the protected flows by short term, high volume withdrawals.

The statistical analysis used to identify rare and critical events and duration periods should not form the basis for protecting flows; that is the purpose of the flow study.

Response: Statistical methods are required to evaluate the biological data collected on the Souhegan. As described in the proposal, the flow study uses statistical methods to assess biological parameters of fish habitat including canopy cover, water depth, substrate material and water velocity. Measured values of habitat parameters from the Designated River are used to determine whether Souhegan fish species would use that habitat. Fish preferences for depth, flow

velocity, substrate, and cover were compared to the measured habitat parameters to determine whether habitats were suitable, not suitable or optimal over a range of flows.

Statistical methods are necessary to evaluate these biological data that identify suitable habitat conditions for aquatic species and how that suitability will change with changes in flow. The evaluation of flow levels, and of allowable and catastrophic durations, are directly linked to these measured habitat-specific parameters. The purpose of the instream flow study is to identify the protected flows that were determined based on protecting the amount and duration of suitable habitat within each bioperiod.